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ECONOMIC INTELLIGENCE REPORT

MAJOR AROMATIC CHEMICALS IN THE USSR

CIA/RR 60
27 June 1955

CENTRAL INTELLIGENCE AGENCY
OFFICE OF RESEARCH AND REPORTS

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(ORR Project 22.454)

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MAJOR AROMATIC CHEMICALS IN THE USSR*

Summary

The production of the major aromatic chemicals** -- benzol, toluol, and phenol -- is a significant sector of the Soviet chemical industry. These chemicals are essential inputs in the manufacture of products which are of basic importance to an industrial economy in both peace and war -- plastics, synthetic rubber, high-octane gasoline, dyes, insecticides, solvents, pharmaceuticals, and high explosives.

The major aromatic chemicals are obtained in the USSR primarily as byproducts of the production of high-temperature coke. Benzol and toluol are also produced from the pyrolysis of petroleum fractions, and phenol is obtained synthetically from benzol and as a byproduct of the low-temperature carbonization of coal. Although Soviet technology of production of coke byproducts is comparable to that in the US, Soviet technology of the production of aromatic chemicals -- particularly toluol -- from petroleum apparently lags behind that of the US.

Production of benzol in the USSR in 1954 is estimated at 335,000 metric tons.*** Of this total, 41,000 tons were exported, and 294,000 tons were available for domestic consumption. Requirements in 1954 were an estimated 212,000 tons. The surplus of 82,000 tons was allocated to use as motor fuel and, possibly, additions to stockpiles. In the event of war, requirements for benzol would increase considerably, and the quantities now being exported and consumed as motor fuel could be channeled into wartime uses. Such diversions would be supplemented, probably, by expanded production of benzol. It is estimated that between 1954 and 1958 production will increase by 34 percent.

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* The estimates and conclusions contained in this report represent the best judgment of ORR as of 1 April 1955.

** In current use the term aromatic chemicals refers to benzol and compounds related to benzol (C_6H_6) whose molecular structures contain one or more carbon rings.

*** Throughout this report, tonnages are given in metric tons.

Soviet production of toluol in 1954 is estimated at 104,000 tons. Of this total, 5,500 tons were exported, and 98,500 tons were available for domestic consumption. Essential civilian requirements are estimated at 5,000 to 10,000 tons, leaving about 90,000 tons of toluol for the production of explosives. This amount would produce about 190,000 tons of TNT, or 380,000 to 480,000 tons of amatol. For comparison, the late 1954 rate of production of TNT in the US was 83,000 tons per year. It seems likely that the USSR has sufficient toluol to meet current civilian and military requirements. Although it is probable that the current supply of toluol would not be sufficient to meet expanded requirements of a full-scale war, there are potentially available to the USSR several measures by which the increased demands could be met. Principal among these would be production of toluol from the Kitoy Synthetic Fuels Plant (currently under construction in East Siberia, Economic Region XI*) and from the catalytic reforming of petroleum fractions. It is estimated that between 1954 and 1958 toluol production will increase by 27 percent.

Soviet production of phenol in 1954 is estimated at 34,000 tons. In addition, 3,000 tons were imported from East Germany, giving a total of 37,000 tons available for domestic consumption. Of this amount, 23,200 tons are estimated to have been consumed for the manufacture of phenolic resins. There is evidence, however, that the supply of phenol was insufficient to meet requirements, especially those for plastics. The available capacity for production of phenolic plastics has not been fully utilized because of the shortage of phenol. It is expected, however, that in 1955 and 1956 production will expand to about double the 1954 level. Further large expansion probably will take place about 1960, when additional units are scheduled to go into production. Thus it is reasonable to expect that the USSR will soon be capable of satisfying phenol requirements for both civilian and military uses.

The Soviet supply of benzol, toluol, and phenol is not dependent to any extent on imports and is therefore not vulnerable to proscription, commodity controls, or blockade. No significant internal weaknesses in the industry have been identified.

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Soviet preparations for a large-scale war probably would include attempts to increase the output of toluol and its allocation to the production of explosives. Evidences of extensive toluol production at Kitoy or attempts to increase toluol yields at high-temperature coke plants could indicate such intentions. Reallocation of large quantities of benzol and phenol to the manufacture of picric acid would also indicate greatly increased requirements for explosives.

I. Introduction.

A. Significance.

The production of aromatic chemicals and byproduct chemicals from coking is a major sector of the Soviet chemical industry. Although this group contains scores of chemicals from diverse sources, only the most important -- benzol, toluol, and phenol -- are discussed in detail in this report. Estimates of production of byproduct ammonia, byproduct ammonium sulfate, xylol, cresol, and naphthalene are given in Appendix A.

During peacetime, major quantities of benzol, toluol, and phenol are used in the production of such materials as plastics, synthetic rubber, high-octane gasoline blending agents, dyes, insecticides, solvents, and pharmaceuticals. During wartime the requirement for toluol in the manufacture of high explosives would consume a major part of the total available supply.

The increasing production of plastics, synthetic rubber, and insecticides has created an expanding demand for aromatic chemicals. To satisfy this demand, additional sources of raw material and additional processes for production of the major aromatic chemicals have been developed.

B. Technology.

The technology of production of aromatic chemicals is thoroughly discussed in literature relating to the industry. As far as this report is concerned, the significant aspects are the Soviet level of technology and the variety of processes and raw materials used in the USSR. Benzol and toluol are obtained in the USSR as by-products in the production of high-temperature coke and from the pyrolysis (a destructive form of thermal cracking) of petroleum fractions. Phenol is also produced as a high-temperature coke by-product and, in addition, is obtained synthetically from benzol and as a byproduct of the low-temperature carbonization of coal.

The yields of refined chemicals from processes in which coal or petroleum are involved can be varied widely. The oils and tars (the source of the chemicals) may be used unrefined, only certain materials may be extracted, or the maximum amount of each chemical may be obtained. Furthermore, the process can often be adjusted to maximize production of certain chemicals by selection of raw material or at the expense of other products.

Since World War II the production of toluol from petroleum fractions by catalytic reforming has supplied the bulk of US requirements. There is no evidence, however, that the USSR has yet operated a commercial plant employing this process. Although Soviet technology of production of coke byproducts is comparable to that in the US, Soviet technology of production of aromatics -- particularly toluol -- from petroleum apparently lags behind that of the US.

C. Organization.

Because of the varied sources of aromatic chemicals, there are several organizations responsible for their production in the USSR. Production from high-temperature coke plants was the responsibility of the Chief Directorate of Coke and the All-Union Ministry of Ferrous Metallurgy. 1/* In late 1953 this ministry was reorganized as a Union-Republic Ministry of the USSR and a Union-Republic Ministry of the Ukrainian SSR. 2/ The subordination of the coke plants since the reorganization is not clear. The assumption is that those plants in the Ukraine are directly subordinate to the Ukrainian Ministry and the others are subordinate to the Ministry of the USSR.

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The production of synthetic phenol from benzol is the responsibility of the Ministry of the Chemical Industry (the Chief Directorate being unknown). 3/ Under the Ministry of the Petroleum Industry the Chief Directorate of Synthetic Fuels and Gases is responsible for production of phenol from synthetic fuels plants, 4/ and the Chief Directorate of Refining is responsible for pyrolysis operations. 5/

II. Supply.

A. Production.

1. High-Temperature Coke Plants.

High-temperature coke plants are by far the most important sources of benzol and toluol in the USSR. They also produce about one-third of the total supply of phenol.

Average yields of benzol, toluol, and phenol per ton of high-temperature coke in the USSR are given in Table 1.

Table 1

Average Yields of Benzol, Toluol, and Phenol per Ton of High-Temperature Coke in the USSR

Kilograms

Product	Yield
Benzol a/	7.75
Toluol b/	1.93
Phenol c/	0.309

a. 6/
b. 7/
c. 8/

Estimated production of high-temperature coke in the USSR for selected years from 1940 to 1954 is given in Table 2.

Table 2

Estimated Production of High-Temperature Coke in the USSR a/
Selected Years, 1940-54

Million Metric Tons

Year	Coke
1940	19.5
1946	14.3
1950	27.5
1951	31.3
1952	35.7
1953	38.9
1954	42.0

a. For derivation of this table, see Methodology, Appendix B.

Using the data given in Table 2, production estimates of the aromatic chemicals can be calculated. Estimated production of benzol, toluol, and phenol by high-temperature coke plants in the USSR for selected years from 1940 to 1954 is given in Table 3.

Table 3

Estimated Production of Benzol, Toluol, and Phenol by High-Temperature Coke Plants in the USSR
Selected Years, 1940-54

Thousand Metric Tons

Product	1940	1946	1950	1951	1952	1953	1954 a/
Benzol	151	111	213	243	277	301	326
Toluol	38	28	53	60	69	75	81
Phenol	6.0	4.4	8.5	9.7	11.0	12.0	13.0

a. Estimated 1954 regional production is presented in the Methodology, Appendix B.

2. Pyrolysis of Petroleum Fractions.

The pyrolysis of petroleum fractions (normally kerosine or gas oil) yields light oils containing benzol and toluol. At least two methods of treating the light oil may be followed. By one method the components are extracted as relatively pure products. By another, only the toluol is extracted, and the remainder of the light oil may then be used as motor fuel under the name pyrobenzol.

On the basis of published Soviet information the yield of toluol from the pyrolysis of kerosine is estimated at 1.8 percent of the charge. 9/ As indicated above, the yield of benzol is variable. Wartime information on the pyrolysis installation at the Budenny Refinery in Baku indicates that about 30 percent of the benzol is recovered as such, the remainder being used for production of pyrobenzol. 10/

It is estimated that during World War II the USSR operated 9 to 10 pyrolysis plants with a total charge capacity of about 1.3 million tons of petroleum fractions.* It is assumed that these plants are still in production. Because of the inefficiency of the process, however, little or no expansion of this capacity has taken place. It is assumed that the production of benzol is still at a rate similar to that reported at the Budenny installation. The estimated average annual production of benzol by the pyrolysis of petroleum fractions during the 1945-54 period was 9,000 tons and that of toluol, 23,000 tons.

3. Low-Temperature Carbonization of Coal.

Two plants in the USSR are believed to produce substantial quantities of phenol as a byproduct from the low-temperature carbonization of coal. A plant at Stalinogorsk (Central, Region VII) has been operating since before World War II. Its annual production is estimated at about 3,600 tons of phenol. 11/

At Kitoy, near Lake Baykal (East Siberia, Region XI), a synthetic fuels plant is currently starting operation. 12/ Raw material for this plant is tar obtained from low-temperature carbonization of coal; phenol is produced as a byproduct. Although the first section of this plant will ultimately produce some 34,000 tons of phenol, production in 1954 (the first year of operation) is estimated at 8,500 tons. 13/

* See Methodology, Appendix B.

Four additional low-temperature carbonization plants are believed to be operating in the USSR. On the basis of the estimated liquid fuels capacity of these plants, however, the production of phenol is considered to be negligible. 14/

4. Synthetic Phenol Plants.

It is believed that two synthetic phenol plants are operating in the USSR -- one at Berezniki (Urals, Region VIII) and the other at Kemerovo (West Siberia, Region IX). Both plants have been reported as having a wartime annual capacity to produce 10,000 tons of picric acid from synthetic phenol. 15/ Production of this amount of picric acid would require about 4,500 tons of phenol. It is estimated, therefore, that the combined production of these plants is about 9,000 tons of synthetic phenol per year.

Synthetic phenol plants were also reported at both Stalinogorsk (Central, Region VII) and Chapayevsk (Volga, Region VI). 16/ It is believed, however, that the plant reported at Stalinogorsk was actually the low-temperature carbonization plant existing there. German intelligence reported picric acid production at Chapayevsk but stated that phenol was shipped into the plant. 17/ No confirmation of a phenol plant at Chapayevsk has been found, and the German interpretation is accepted.

5. Summary of Production Data and Regional Distribution of Production.

Estimated total production of benzol, toluol, and phenol in the USSR in 1954 is given in Table 4.*

Estimated total production of benzol, toluol, and phenol, in the USSR for selected years from 1940 to 1953 is given in Table 5.*

Estimated regional distribution of production of benzol, toluol, and phenol in the USSR in 1954 is given in Table 6.**

* Tables 4 and 5 follow on p. 9.
** Table 6 follows on p. 10.

Table 4

Estimated Total Production of Benzol, Toluol, and Phenol in the USSR
1954

Thousand Metric Tons

Product	Process				
	Metallurgical Coking	Pyrolysis	Low-Temperature Carbonization	Synthesis	Total
Benzol	326	9	0	0	335
Toluol	81	23	0	0	104
Phenol	13	0	12	9	34

Table 5

Estimated Total Production of Benzol, Toluol, and Phenol in the USSR
Selected Years, 1940-53

Thousand Metric Tons

Product	1940 a/	1946	1950	1951	1952	1953
Benzol	160	120.6	221.6	251.6	285.6	310.6
Toluol	60	51	76	83	92	98
Phenol	18.6	17.1	21.1	22.3	23.6	24.6

a. In estimating 1940 total production, it was assumed that output from pyrolysis, from the Stalinogorsk low-temperature carbonization plant, and from synthesis was the same as for the postwar years.

Table 6

Estimated Regional Distribution of Production of Benzol, Toluol, and Phenol in the USSR a/
1954

Economic Region	Benzol		Toluol		Phenol	
	Amount (Thousand Metric Tons)	Percent	Amount (Thousand Metric Tons)	Percent	Amount (Thousand Metric Tons)	Percent
North and Northwest, I	0	0	0	0	0	0
West, II	0	0	0	0	0	0
Ukraine, III	140	42	34.9	34	5.5	16
Southeast, IV	1.4	b/	3.6	3	0	0
Transcaucasus, V	4.3	1	7.2	7	c/	b/
Volga, VI	0.7	b/	1.8	2	0	0
Central, VII	2.0	1	5.3	5	3.6	11
Urals, VIII	71.2	22	19.3	19	7.3	21
West Siberia, IX	38	12	9.5	9	6.0	18
Kazakhstan and Central Asia, X	1.4	b/	3.6	3	0	0
East Siberia, XI	1.5	b/	0.3	b/	8.6	25
Far East, XII	0	0	0	0	0	0
Unallocated production	74.5	22	18.5	18	3.0	9
Total	335.0	100	104.0	100	34.0	100

a. For derivation of this table, see Methodology, Appendix B.
b. Less than 0.5 percent.
c. Less than 0.05.

B. Comparison of Soviet and US Production and Prices.

A comparison of production of benzol, toluol, and phenol in the USSR in 1954 and in the US in 1953 is given in Table 7.

Table 7

Comparison of Production of Benzol, Toluol, and Phenol in the USSR, 1954, and in the US, 1953

Product	Amount (Thousand Metric Tons) USSR 1954	US 1953 a/	USSR as Percent of US
Benzol	335	911	36.7
Toluol	104	440	23.6
Phenol	34	172	19.8

a. 18/

A comparison of the prices of benzol, toluol, and crude phenol in the USSR in 1950 and in the US in 1955 is given in Table 8.*

There is a possibility that Soviet prices for these chemicals have been reduced since 1950; in that event the ruble-dollar ratios shown in Table 8 would be reduced.

C. Trade.

1. With Soviet Bloc Countries.

Estimated Soviet trade in benzol, toluol, and phenol with Soviet Bloc countries in 1952-54 is given in Table 9.*

* Tables 8 and 9 follow on p. 12.

Table 8

Comparison of Prices of Benzol, Toluol, and Crude Phenol in the USSR, 1950, and in the US, 1955 a/

Product	USSR 1950 Rubles per Metric Ton b/	US 1955 Dollars per Metric Ton c/	Rubles per Dollar
Benzol	1,440	120	12
Toluol	1,980	103	19
Crude Phenol	2,880	347	8.3

a. US prices are those for the beginning of 1955.
b. 19/
c. 20/

Table 9

Estimated Soviet Trade in Benzol, Toluol, and Phenol with Soviet Bloc Countries 1952-54

Thousand Metric Tons

Product	From	To	Year	Amount
Benzol	USSR	East Germany	1952	14.5 a/
			1953	14.0 b/
			1954	11.0 b/ c/
Toluol	USSR	East Germany	1952	5.4 d/
			1953	5.6 b/
			1954	5.5 e/
Phenol	East Germany	USSR	1954	3.0 c/ f/

a. 21/
b. 22/
c. Planned.
d. 23/
e. Estimated on the basis of 1952 and 1953 shipments.
f. 24/

2. With Non-Soviet Bloc Countries.

The only substantial trade reported between the USSR and non-Soviet Bloc countries in 1953 is a sale of 8,000 tons of benzol by the USSR through Sweden and England. 25/ Numerous other Soviet offers of benzol and toluol were made in late 1953, but there is no evidence to indicate that sales were made.

In the second quarter of 1954 the USSR concluded a contract with a West German firm for the export to West Germany of 30,000 tons of benzol. 26/ It is assumed that this shipment was, or will be, made. The trade agreement between France and the USSR for the period 1 July 1954 to 31 December 1955 includes the supply by the USSR of 20,000 tons of benzol and 1,500 tons of toluol. 27/ Because of the dates on this agreement, these exports were not included in 1954 trade. The agreement serves, however, to point out that there is substantial trade in benzol with the West.

D. Stockpiling.

There is no evidence of stockpiling of aromatic chemicals in the USSR. It is probable, however, that because of their importance in wartime, toluol and possibly benzol and phenol are being stockpiled. Benzol and toluol are fairly easy to store, requiring only tankage of the type used for petroleum products. Phenol is corrosive and requires zinc or enamel-lined tanks or drums.

E. Supply Balance.

The supply of benzol, toluol, and phenol available in the USSR for domestic consumption in 1954, after exports and imports and not considering possible stockpiles, is estimated as follows:

Product	Supply (Metric Tons)
Benzol	294,000
Toluol	98,500
Phenol	37,000

III. Consumption.

A. Current Use Patterns.

1. Benzol.

The estimated use pattern of benzol in the USSR in 1954 is given in Table 10.

Table 10

Estimated Use Pattern of Benzol in the USSR a/
1954

Thousand Metric Tons

Use	Amount
Alkyl benzols (for use in blending aviation gasoline)	100
Phenol	9
Styrene	11
Aniline	20
Chlorobenzol	5
Miscellaneous (insecticides, denaturants, drugs and pharmaceuticals, solvents)	67
Total chemicals	212
Motor fuel	82 b/
Total consumption	294

a. For the derivation of this table, see Methodology, Appendix B.
b. This amount was obtained as a residual after estimated uses were subtracted from total supply.

2. Toluol.

The principal peacetime uses for toluol in the US are as a solvent for paints, varnishes, and lacquers; as an additive in the blending of aviation gasoline; and -- to a lesser extent -- in the manufacture of chemicals, drugs, and pharmaceuticals. Substitutes are available for most of these uses, and during wartime almost all of the toluol would be available for the manufacture of explosives.

Although the toluol use pattern in the USSR is not clear, it is probable that only a minimum of toluol is channeled into peacetime uses -- principally chemicals, drugs, and pharmaceuticals. On the basis of US analogy, it is estimated that from 5,000 to 10,000 tons would probably cover these requirements, leaving about 90,000 tons for the manufacture of high explosives and for any stockpiling that is being done. This amount would allow production of about 190,000 tons of TNT.

3. Phenol.

The estimated use pattern of phenol in the USSR in 1954 is given in Table 11.

Table 11

Estimated Use Pattern of Phenol in the USSR
1954

Thousand Metric Tons

Use	Amount
Phenol formaldehyde resins	23.2 a/
Miscellaneous uses (salicylic acid, solvent extraction, dyes, disinfectants)	13.8 b/
Total consumption	37.0

a. For the derivation of this figure, see Methodology, Appendix B.
b. This amount was obtained as a residual.

It is possible that a small amount of phenol could be reserved for production of picric acid, but the quantity probably would not exceed 2,000 to 3,000 tons.

B. Current Requirements.

1. Benzol.

As indicated in Table 10,* 82,000 tons of benzol were used as motor fuel in the USSR in 1954. The blending of benzol in motor fuel is not considered an essential use but as a convenient way to utilize a surplus. Before World War II the US consumed over half of the benzol supply as motor fuel. This practice continued until more essential requirements (particularly those for synthetic rubber and polystyrene plastics) increased to the extent that no benzol was available for use as motor fuel.

The Soviet contract to export 30,000 tons of benzol to West Germany and the trade agreement with France for the export of 20,000 tons are further evidences that the USSR has a benzol surplus and that essential domestic requirements are being satisfied. These requirements are estimated in Table 10* at 212,000 tons.

2. Toluol.

As indicated above,** there appears to be sufficient toluol to meet the essential civilian requirements and also to leave about 90,000 tons for production of about 190,000 tons of TNT and for stockpiling. There is at present no available information indicating current Soviet requirements for high explosives. Allocation of toluol to production of TNT in the US in 1954 was about 40,000 tons a year, enough to produce 83,000 tons of TNT. Contrary to US practice, the USSR generally stretches TNT supplies by adding ammonium nitrate (usually a 1-to-1 ratio). The resulting mixture is called amatol. By this method, 190,000 tons of TNT could produce 380,000 to 480,000 tons of high explosives. This is considerably more than the US is currently producing, and it seems likely that currently the USSR has sufficient toluol available to meet both civilian and military requirements.

* P. 14, above.
** P. 15, above.

3. Phenol.

A recent Soviet statement said that the available production capacities for plastics were not being fully utilized because of shortages of certain raw materials. The statement went on to add that the capacity for phenol production must be sharply increased to help alleviate this situation. 28/ Furthermore, the planned import of 3,000 tons of phenol from East Germany in 1954 is somewhat extraordinary. As far as is known, no shipments of this size were made in the years immediately before 1954.

Thus it seems that the 1954 supply of phenol was insufficient to meet requirements, especially those for plastics. As previously stated, it is not known how much, if any, phenol was used for the manufacture of picric acid. In the light of this situation, however, it is probable that the USSR would rely on toluol for production of high explosives and would channel phenol to the manufacture of essential plastics and to civilian use.

C. Wartime Requirements.

1. Benzol.

The requirements for benzol in the USSR in the event of war can reasonably be expected to increase in the following fields: (a) manufacture of alkyl benzols for addition to aviation gasoline, (b) production of aniline for use in the manufacture of the high explosive tetryl, (c) production of styrene for manufacture of butadiene-styrene synthetic rubber and polystyrene plastics, (d) production of insecticides and drugs and pharmaceuticals, and (e) possibly in the production of dinitrochlorobenzol for production of picric acid.* No quantitative estimates of these increases can be made.

Maximum production from pyrolysis installations would provide an additional 20,000 tons of benzol. Considering as surplus the amount currently being exported and used for motor fuel, 112,000 tons, it is estimated that the USSR has a "cushion" of about 132,000 tons of benzol (over one-third of the total supply) available for the

* Production of large quantities of picric acid in a future war is problematical because TNT and RDX are the preferred explosives. If toluol and methanol are short, however, the USSR may be forced to rely on picric acid from both phenol and dinitrochlorobenzol.

increased requirements of war. In the US, estimated direct and indirect military and essential civilian requirements for a projected emergency have been calculated as the same as recent yearly consumption. 29/ Considering that the USSR has a "cushion" equal to 50 percent of its current requirements, it is probable that increased requirements in wartime can be satisfied from present sources of supply.

2. Toluol.

In the event of war the USSR probably could channel the total output of toluol to production of explosives. The 1954 production of 104,000 tons of toluol would yield about 216,000 tons of TNT. It is estimated that during 1944 domestically produced toluol plus Lend-Lease explosives provided the USSR with about 225,000 tons of TNT.* In addition, the USSR received substantial quantities of filled ammunition. In 1944 the US produced 740,000 tons of TNT. 30/

It seems likely, then, that the current Soviet production of TNT would not be sufficient to meet the requirements of a full-scale war. Several measures could be taken to solve such a problem. First, and most probable, large quantities of toluol could be obtained from the Kitoy Synthetic Fuels Plant if the need for toluol justified reducing the aviation gasoline production at this plant. Second, benzol could be used to produce picric acid and thus help satisfy requirements for high explosives. Third, the TNT component of amatol could be reduced, although not satisfactorily, as far as 1 to 9. This mixture is much harder to load, but it would greatly extend supplies of TNT. Fourth, production of toluol from coke ovens can be increased 30 percent to 100 percent over present production by charging kerosine or lignite into the subroof space of the ovens after coking has proceeded several hours. Fifth, development of catalytic reforming of petroleum fractions possibly could provide a source of large quantities of toluol. The information on the extent to which this process has been developed by actual production is not conclusive. By way of illustration, in the US during World War II, one catalytic reforming plant produced 250.000 tons of toluol a year.

* See Methodology, Appendix B.

Although the present production of toluol may not be sufficient to satisfy wartime requirements, there are measures available which could remedy a shortage. Production of toluol from the Kitoy Synthetic Fuels Plant and catalytic reforming of petroleum fractions could probably provide several times as much toluol as is being produced currently in the USSR.

3. Phenol.

A shortage of phenol to meet current requirements has already been indicated. It is reasonable to assume that during wartime, requirements for plastics would increase substantially because phenolic resins are widely used in aircraft, in electrical and electronic parts, in gun and shell parts, and in ships. Other uses for phenol -- in drugs and pharmaceuticals, in solvent extraction of petroleum products, and the like -- probably would increase and almost certainly would not go below the current level. Thus it can be reasoned that the USSR currently does not have a phenol supply sufficient to meet the requirements of war.

Because of the construction of new capacity,* phenol production in the USSR probably will expand rapidly during 1955-56 to a total of about 71,000 tons. This expansion would about double the present supply and would place the USSR in a better position to meet the expanded demands of war. Because no quantitative estimate of wartime requirements is available, it is not possible to determine definitely whether or not this expanded supply (71,000 tons) would completely satisfy the requirements.

As explained below,* an additional production capacity of 34,000 tons of phenol probably will be completed about 1960. With the estimated increase in coke-oven phenol the total production capacity at that time will be about 110,000 tons. This amount (three times current production) would almost certainly satisfy wartime requirements.

In the event of war before 1960 the phenol supply situation could be eased substantially by the use of substitute materials. By employing cresol in the manufacture of resin, large quantities of phenol could be saved for more strategic uses. Cresol formaldehyde resins, although not so suitable as phenol formaldehyde for some uses,

* See IV, C, below.

can be employed in a variety of applications -- thus stretching the phenol supply. It is estimated that the USSR, if it were necessary, could currently produce for this purpose about 18,000 tons of cresol from coal tar.* This amount would save about the same quantity of phenol.

Urea and melamine resins can replace the phenolic types in certain applications. Although production probably is still somewhat limited in the USSR, these resins do represent possible substitutes.

In some nonresin applications of phenol, other chemicals -- chlorobenzol, for example -- can often be substituted. Generally, however, it is more desirable to use a product which does not require phenol in its manufacture. This is possible in the case of such items as dyes, fungicides, and wood treatment chemicals.

It is believed, therefore, that with the estimated expansion of supply in 1955 and 1956 to about twice that of the present (and several times that of World War II) and with the possibilities of substitution as outlined above, the USSR should be capable of satisfying the increased wartime demands for phenol.

IV. Expansion of Production Capacity.

A. Benzol.

The main expansion in the production of benzol probably will result from increases in production of high-temperature coke. Because of the inherent inefficiency of the pyrolysis operation, production by that method probably will not increase. (As previously pointed out, however, the USSR may choose to separate more benzol from the light oils produced by pyrolysis.) Catalytic reforming of petroleum fractions, even if undertaken on a large scale, generally produces only small amounts of benzol.

Estimates for future years, then, have been primarily based on projected production of coke.** Estimated production of benzol in the USSR in 1955-58 is given in Table 12.***

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* See Appendix A.
** See Methodology, Appendix B.
*** Table 12 follows on p. 21.

Table 12

Estimated Production of Benzol in the USSR
1955-58

Year	Amount a/ (Thousand Metric Tons)	Index (1954 = 100)
1955	362	108
1956	391	117
1957	420	125
1958	448	134

a. An estimated 9,000 tons from pyrolysis has been included for all years.

B. Toluol.

Estimated 1955-58 production of toluol in the USSR has been calculated in the same way as that of benzol: a figure based on expanding production of coke has been added to a constant production of 23,000 tons of toluol a year from pyrolysis. It is probable that production of toluol from the plant at Kitoy or by catalytic reforming of petroleum fractions will not be a factor in these years unless there are sudden large demands for toluol. Estimated production of toluol in the USSR in 1955-58 is given in Table 13.*

C. Phenol.

The production of phenol in the USSR is scheduled, apparently, for a period of rapid expansion. By 1955 the first section of the synthetic fuels plant at Kitoy should be fully operating and should be producing 34,000 tons of phenol, 25,500 tons more than the estimated 1954 production. 31/ In addition the USSR has stated that in 1955 a new phenol production facility (probably synthetic) should start operation at the Karbolit plastics plant in Kemerovo. This new unit will supply phenol for the production of phenolic resins and molding powders.

* Table 13 follows on p. 22.

Table 13

Estimated Production of Toluol in the USSR
1955-58

Year	Amount a/ (Thousand Metric Tons)	Index (1954 = 100)
1955	111	107
1956	118	113
1957	125	120
1958	132	127

The plastics plant itself is to be increased to three times its present size, to an estimated production of 10,500 tons of phenolic resin. About 9,200 tons of phenol per year would be required from the new phenol plant to satisfy the requirements of the expanded production of plastics. 32/

Estimated production of phenol in the USSR in 1955-58 is given in Table 14.* The estimates were obtained by adding the estimated production of the Kitoy and Kemerovo plants to estimates of byproduct phenol derived from projected coke production estimates and to estimated production by the two synthetic plants and by the Stalinogorsk low-temperature plant.

At the Kitoy Synthetic Fuels Plant the USSR plans to construct a second section, identical to the first, which will also produce 34,000 tons of phenol. 33/ It is estimated that this unit will enter production in 1959 or 1960. 34/ Including the additional phenol from expanded coke production, the USSR will produce an estimated 110,000 tons of phenol in 1960.

* Table 14 follows on p. 23.

Table 14

Estimated Production of Phenol in the USSR
1955-58

Year	Amount (Thousand Metric Tons)	Index (1954 = 100)
1955	60.7 a/	179
1956	71.0 a/	209
1957	72.2	212
1958	73.3	216

a. It is estimated that in 1955 the synthetic fuels plant at Kitoy will produce 34,000 tons of phenol and that the new synthetic phenol plant at Kemerovo will not be in full operation until 1956.

V. Inputs.

A. For Chemicals from High-Temperature Coke Operations.

The estimated inputs to high-temperature coke operations for production of benzol, toluol, and phenol in the USSR in 1954 are given in Table 15.*

B. For Chemicals from Pyrolysis of Petroleum Fractions.

The estimated input of petroleum fractions to pyrolysis stills was given in the production section of this report as 1.3 million tons.** In addition, it is estimated that 10,000 tons of 100-percent sulfuric acid would be required for treatment of crude fractions.***

* Table 15 follows on p. 24.
** P. 7, above.
*** See Methodology, Appendix B.

Table 15

Estimated Inputs to High-Temperature Coke Operations for Production of Benzol, Toluol, and Phenol in the USSR a/
1954

Input Material	Amount	
	Thousand Metric Tons	Million KWH
Sulfuric acid (100 percent)	53 b/	
Caustic soda (100 percent)	16.8	
Solar oil c/	84	
Electric power		800 d/

a. Inputs are estimated on the basis of 1954 production of 326,000 tons of benzol, 81,000 tons of toluol, and 13,000 tons of phenol (see Table 3, p. 6, above). See Methodology, Appendix B.
b. An additional 405,000 tons of sulfuric acid would be necessary for the production of byproduct ammonium sulfate. See Appendix A.
c. Solar oil is a petroleum fraction used to absorb crude benzol from coke-oven gas.
d. This figure represents power required for the complete coke and chemical plant. 35/

C. For Phenol from the Low-Temperature Carbonization of Coal.

It is estimated that 5,400 tons of caustic soda would be required to produce 12,100 tons of phenol (1954 production) from low-temperature carbonization of coal.*

D. For Phenol from Synthetic Plants.

Both of the synthetic phenol plants in the USSR are reported to be operating with the benzene sulfonate method. To produce 9,000 tons of synthetic phenol with this process requires approximately

* See Methodology, Appendix B.

9,000 tons of benzol, 15,000 tons of 100-percent sulfuric acid, and 15,000 tons of caustic soda. Steam and electricity requirements are very small. 36/

E. Total Inputs.

Estimated major inputs for the production of benzol, toluol, and phenol in the USSR in 1954 are given in Table 16.

Table 16

Estimated Major Inputs for Production of Benzol, Toluol, and Phenol in the USSR a/ 1954

Input Material	Amount	
	Thousand Metric Tons	Million KWH
Sulfuric acid (100 percent)	75 b/	
Caustic soda (100 percent)	37.1	
Solar oil	84	
Petroleum fractions (kerosine or gas oil)	1,300	
Benzol	9	
Electric power		800 c/

a. Inputs are estimated on the basis of 1954 production of 335,000 tons of benzol, 104,000 tons of toluol, and 34,000 tons of phenol (see Table 4, p. 9, above).
b. An additional 405,000 tons of sulfuric acid would be necessary for production of byproduct ammonium sulfate. See Appendix A.
c. This figure represents power required for the complete coke and chemical plant.

VI. Capabilities, Vulnerabilities, and Intentions.

A. Capabilities.

1. Benzol.

The USSR not only is capable of meeting current requirements for benzol but also has a considerable surplus available for exports and for use as motor fuel. On the basis of projected US requirements for war, it is estimated that the present Soviet supply of benzol is sufficient to meet wartime requirements.

2. Toluol.

The supply of toluol in the USSR is sufficient to meet current civilian requirements and to provide substantial quantities (up to 90,000 tons) for the production of military explosives. It is estimated that the industry is capable of meeting expanded wartime requirements for toluol. This can be done by increasing production from present sources and by utilizing additional sources such as the possibility of catalytic reforming and the potential output from the Kitoy Synthetic Fuels Plant, currently under construction.

3. Phenol.

The 1954 supply of phenol was not adequate for requirements, especially those for the production of plastics. The industry is rapidly expanding production, however, and within a few years should be able to provide sufficient phenol for domestic requirements. The same situation probably applies to wartime requirements. Present supply apparently is not great enough to satisfy the demands of war, but the projected expanded supply should be adequate.

B. Vulnerabilities.

The Soviet supply of benzol, toluol, and phenol is not dependent on imports and is therefore not vulnerable to commodity controls, blockade, or other means of cutting off imports. No significant internal industrial weaknesses are apparent.

C. Intentions.

Soviet preparations for a large-scale war would probably include attempts to increase the output of toluol and its allocation to the production of explosives. Evidence of extensive production of toluol at Kitoy or attempts to increase toluol yields at high-temperature coke chemical plants could indicate such intentions. Reallocation of large quantities of benzol and phenol to picric acid manufacture might also indicate greatly increased requirements for explosives.

APPENDIX A

PRODUCTION OF LESS IMPORTANT BYPRODUCT CHEMICALS

1. From High-Temperature Coke Operations.

According to Soviet technical literature, the yield of the less important chemicals per ton of high-temperature coke is as follows 37/:

Product	Kilograms
Xylol	0.67
Cresol	0.429
Naphthalene	2.32
Ammonia	4.0

It is estimated that 90 percent of the yield of ammonia is converted to ammonium sulfate for use as fertilizer. 38/

2. From Pyrolysis Operations.

The yield of naphthalene from pyrolysis operations is estimated at 0.55 percent of the charge; with a charge of 1.3 million tons the yield would be 7,200 tons. 39/

3. Total.

Estimated total production of xylol, cresol, naphthalene, byproduct ammonia, and byproduct ammonium sulfate in the USSR for selected years from 1940 to 1954 is given in Table 17.*

* Table 17 follows on p. 30.

Table 17

Estimated Total Production of Xylol, Cresol, Naphthalene, Byproduct Ammonia, and Byproduct Ammonium Sulfate in the USSR a/ Selected Years, 1940-54

Thousand Metric Tons

Product	1940	1946	1950	1951	1952	1953	1954
Xylol	13	9.6	18.4	21.0	23.9	26	28.1
Cresol	8.4	6.2	11.7	13.4	15.3	16.7	18.0
Naphthalene	52.4	40.4	71.0	79.8	90.0	97.4	104.6
Byproduct ammonia	7.8	5.8	11.0	12.5	14.3	15.6	16.8
Byproduct ammonium sulfate	251	187	353	403	459	500	540

a. All production came from high-temperature coke plants and pyrolysis operations.

APPENDIX B

METHODOLOGY

1. Estimate of High-Temperature Coke Production in the USSR.

A 1945 estimate of Soviet production of high-temperature coke was obtained from the Fourth Five Year Plan (1946-50), in which it was stated that 30 million tons of coke would be produced in 1950 and that during the period of the Plan, 19.1 million tons of coke capacity would be built or reconstructed. 40/ Assuming that the new capacity would produce about 17.2 million tons of coke (90 percent of capacity), there must have existed a capacity for the production of 12.8 million tons before the Plan. Production in 1945 is thus estimated at 12.8 million tons -- 1.42 times the estimated 1945 production of pig iron, 9 million tons. 41/

The 1950 estimate of production of high-temperature coke was obtained from statistics concerning coke-oven gas as published in two Soviet technical books. The percentage of coke-oven gas shipped out of coke plants was reported for both 1933 and 1950. It was also stated that the amount shipped out in 1950 was 11.4 times that shipped in 1933. 42/ The total production of coke-oven gas was given for 1933, so a similar figure for 1950 could be calculated. 43/ Thus 1950 production of coke-oven gas was estimated at 10.5 billion cubic meters. For purposes of planning, the USSR has used a figure of 390 cubic meters of coke-oven gas per ton of coke. 44/ This would give production of 27 million tons of coke -- not including coke produced at gashouses. Gashouse coke has been estimated at 500,000 tons. 45/ The total 1950 estimated production, therefore, is 27.5 million tons -- 1.42 times the estimated 1950 production of pig iron, 19.3 million tons. 46/

Seventy to 80 percent of the high-temperature coke produced in the USSR is utilized for production of pig iron. It is reasonable, therefore, to assume a relation between these two commodities. Production of coke in 1945 and 1950 was, for both years, 1.42 times the production of pig iron. This factor, then, has been used to determine production of high-temperature coke for those postwar years for which independent estimates are not available.

Production of pig iron for postwar years was as follows:

Year	Production (Million Metric Tons)
1946	10.1*
1947	11.5**
1948	14.0***
1949	16.7***
1951	22.0***
1952	25.1***
1953	27.4***
1954	29.5***

Total production of coke-oven gas for 1940 has been given by the USSR. Adding about 300,000 tons of coke from gashouses, the 1940 estimate is 19.5 million tons. Estimated production of high-temperature coke for the years 1940 and 1945-54, therefore, is as follows:

Year	Production (Million Metric Tons)
1940	19.5
1945	12.8
1946	14.3
1947	16.3
1948	19.9
1949	23.7
1950	27.5
1951	31.3
1952	35.7
1953	38.9
1954	42.0

* 47/
** 48/
*** 49/

From 1955 through 1960, projections of the production of pig iron have been used.* Estimated production of high-temperature coke for these years, then, is as follows:

Year	Production (Million Metric Tons)
1955	45.5
1956	49.3
1957	53.0
1958	56.6
1959	60.4
1960	64.0

2. Production from Metallurgical Coke Plants, by Oblast and Economic Region.

The estimated production of metallurgical coke in 1954 is 42 million tons. Of this amount, about 32.5 million tons have been identified at specific plants. These plant estimates are as follows:

Location	Plant Name	Production (Thousand Metric Tons)
Ukraine Economic Region, III 50/		
Stalino Oblast		
Zhdanov	Azovstal Metallurgical Plant	1,700
Makeyevka	Novo Makeyevka Coke Chemical Plant No. 4	1,100
Makeyevka	Staro Makeyevka Coke Chemical Plant No. 5	400
Mushketovo	Coke Chemical Plant No. 9	150

* Projected production of pig iron has been calculated by using an estimated annual increase of 2.6 million tons.

Location	Plant Name	Production (Thousand Metric Tons)
Ukraine Economic Region, III		
Stalino Oblast (Continued)		
Stalino	Novo Smolyaninov Coke Chemical Plant No. 8	640
Rutchenkovo	Coke Chemical Plant No. 2	1,100
Stalino	Iron and Steel Works imeni Stalin	300
Kramatorsk	Metallurgical Plant imeni Kuybyshev	132.5
Gorlovka	Novo Gorlovka Coke Chemical Plant No. 3	1,450
Konstantinovka	Coke Chemical Plant No. 17	300
Nikitovka	Coke Chemical Plant No. 13	150
Shcherbinovka	Coke Chemical Plant No. 11	70
Yenakiyevo	Metallurgical Plant imeni Ordzhonikidze (sometimes referred to as Rykov Metallurgical Plant)	1,300
Total Oblast		8,792.5
Voroshilovgrad Oblast		
Bryanskiy	Coke Chemical Plant No. 14	300
Kadiyevka	Coke Chemical Plant	1,000
Uspenka	Olkhovsk Coke Chemical Plant No. 12	500
Voroshilovsk	Metallurgical Works imeni Voroshilov	1,100
Total Oblast		2,900

Location	Plant Name	Production (Thousand Metric Tons)
Ukraine Economic Region, III (Continued)		
Dnepropetrovsk Oblast		
Dnepropetrovsk	Coke Chemical Plant No. 20	940
Dneprodzerzhinsk	Coke Chemical Plant No. 24	1,400
Krivoy Rog	Metallurgical Plant imeni Stalin	880
Total Oblast		3,220
Zaporozh'ye Oblast		
Zaporozh'ye	Metallurgical Combine imeni Ordzhonikidze (sometimes referred to as Zaporozhstal Metallurgical Plant)	2,187.5
Crimean Oblast		
Kerch'	Coke Chemical Plant imeni Kirov	275
Kerch'	Coke Chemical Plant imeni Voykov	700
Total Oblast		975
Total Economic Region III		18,075.0

Location	Plant Name	Production (Thousand Metric Tons)
Urals Economic Region, VIII 51/		
Chelyabinsk Oblast		
Chelyabinsk	Metallurgical Plant imeni Bakal	1,680
Magnitogorsk	Metallurgical Combine imeni Stalin	4,050
Total Oblast		5,730
Sverdlovsk Oblast		
Nizhniy Tagil	Metallurgical Plant imeni Novo Tagil	2,466
Molotov Oblast		
Gubakha	Coke Chemical Plant	900
Total Economic Region VIII		9,096
West Siberia Economic Region, IX		
Kemerovo Oblast		
Kemerovo	Coke Chemical Plant 52/	2,200
Stalinsk	Coke Chemical Plant 53/	2,700
Total Economic Region IX		4,900
Transcaucasus Economic Region, V		
Georgian SSR		
Rustavi	Transcaucasus Metallurgical Combine 54/	160

Location	Plant Name	Production (Thousand Metric Tons)
East Siberia Economic Region, XI		
Noril'sk	Coke Chemical Plant 55/	180
Total of all coke plants		32,411
Unallocated production		9,589

Estimated regional distribution of production of benzol, toluol, and phenol from high-temperature coke plants in the USSR in 1954 is given in Table 18.

Table 18

Estimated Regional Distribution of Production of Benzol, Toluol, and Phenol from High-Temperature Coke Plants in the USSR a/ 1954

	Thousand Metric Tons		
Economic Region	Benzol	Toluol	Phenol
Ukraine, III	140	34.9	5.6
Transcaucasus, V	1.2	0.3	b/
Urals, VIII	70.5	17.5	2.8
West Siberia, IX	38	9.5	1.5
East Siberia, XI	1.4	0.3	0.1
Unallocated production	74.4	18.5	3.0
Total	326.0	81.0	13.0

a. The estimates are based on regional totals of production of metallurgical coke and the yield factors given in Table 1, p. 5, above.
b. Less than 0.05.

3. Estimate of Soviet Wartime Pyrolysis Capacity.

During World War II the Soviet Purchasing Commission conducted negotiations under the Lend-Lease Agreement to obtain nine units for the fractionation of pyrolysis gases. Each of these units was to be able to handle 7,000 cubic meters of gas per hour. The gas was stated to have an average specific gravity of 0.98. 56/ Although the request was later changed to three larger units, the implication is that at least enough pyrolysis capacity existed to produce 63,000 cubic meters of gas per hour. Using Soviet statements to the effect that almost 50 percent of the charge is converted to gas, the total charge to these plants can be calculated as about 1.35 million tons per year.*

This estimate agrees generally with an independent report which estimated that the USSR had 10 pyrolysis plants each capable of handling 300 to 400 tons of charge per day, or a total of about 1.25 million tons per year. 57/

4. Estimate of the Regional Distribution of Production.

The regional distribution of production from high-temperature coke plants is taken from Table 18.** The distribution of production from low-temperature carbonization and synthetic phenol plants is estimated on the basis of the plant locations as given in the production section of the report.***

The estimate of regional distribution of production from pyrolysis is a tenuous one. The production from this source is rather small, however, and errors introduced into the total will not be significant.

There are documented references to some 10 pyrolysis plants in the USSR; these references range in date from the World War I period to the years following World War II. Although some of the plants may have been scrapped and other larger installations built in their place, it is assumed that the documented references indicate the regional locations of the World War II installations.

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* One cubic meter of air equals 1.293 kilograms. Therefore, 1 cubic meter of gas having an average specific gravity of 0.98 would weigh 1.264 kilograms.

** P. 37, above.

*** Pp. 7 and 8, above.

These regional locations are as follows:

Southeast Economic Region, IV	Groznyy 58/ Krasnodar 59/
Transcaucasus Economic Region, V	Baku 60/
Volga Economic Region, VI	Kazan' 61/
Central Economic Region, VII	Konstantinov 62/ Moscow 63/ Gor'kiy 64/
Urals Economic Region, VIII	Ishimbay 65/
Central Asia Economic Region, Xb	Kanibadam 66/ Vannevskiy 67/

The plant at Baku is estimated to produce 2,700 tons of benzol and 6,900 tons of toluol annually. 68/ Dividing the remaining production equally among the other plants, the regional pattern can be established. Estimated regional production of benzol and toluol from pyrolysis of petroleum fractions in the USSR in 1945-54 is given in Table 19.

Table 19

Estimated Regional Production of Benzol and Toluol from Pyrolysis of Petroleum Fractions in the USSR 1945-54

Thousand Metric Tons

Region	Benzol	Toluol
IV	1.4	3.6
V	2.8	6.9
VI	0.7	1.8
VII	2.0	5.3
VIII	0.7	1.8
Xb	1.4	3.6
Total	9.0	23.0

5. Estimates of Use Patterns.

a. Benzol.

The various items in the 1954 estimated use pattern of benzol were calculated as follows:

(1). Alkyl Benzols.

[redacted] 30 percent of the total production of benzol was used for the manufacture of alkyl benzols. 69/

50X1
25X1

(2). Phenol.

The estimated production of synthetic phenol of 9,000 tons would require 9,000 tons of benzol as an input.

(3). Styrene.

Production of butadiene styrene synthetic rubber in the USSR is estimated at 49,000 tons. 70/ This amount would require about 12,000 tons of styrene. It is probable that only small quantities of styrene are going into plastics and that about 12,000 tons may be accepted as the Soviet production. This quantity of styrene would require an input of about 11,000 tons of benzol.

(4). Aniline.

The 1954 production of aniline in the USSR has been estimated by comparing US and Soviet production of dyestuffs (excluding sulfur dyes). According to the 1941 State Plan for Socialist Construction, sulfur dyes account for between one-half and three-fifths of the total production of dyes. 71/ Soviet production of dyes in 1950 is estimated at 69,500 tons. 72/ Of this amount, 40,000 tons are estimated as sulfur dyes, leaving 29,500 tons of other types. 73/

In 1949 the US produced 55,000 tons of dyes (excluding sulfur dyes) and 33,000 tons of aniline. 74/ Thus 1950 production of aniline in the USSR may be roughly estimated as $\frac{29,500}{55,000} \times 33,000$, or 17,700 tons.

Percentage increases in the dye industry for 1951 and 1952 were reported as 15 percent and 8 percent, respectively. 75/ The 1953 percentage increase was not reported and it is assumed that there was none. In the first half of 1954 the dye industry reported a 2-percent increase over the same period of 1953. 76/ Thus production of aniline can be projected from 1950 to a 1954 figure of 22,000 tons. This amount would require 20,000 tons of benzol.

(5). Chlorobenzol.

At least two chlorobenzol plants are known to exist in the USSR. These plants together are estimated to produce 3,000 tons of chlorobenzol annually. 77/ Allowing for additional production of chlorobenzol in unknown plants -- plants for production of DDT and the like -- the total may be estimated at about 5,000 tons. This amount would require about 5,000 tons of benzol.

(6). Miscellaneous.

The estimate for the miscellaneous category was obtained by comparison with recent US use patterns. In 1950, roughly 20 percent of the US benzol supply went to miscellaneous uses such as those listed in the text.* 78/

b. Phenol.

The estimated use of phenol for the manufacture of phenol formaldehyde resins was derived as follows. The 1941 State Plan of the USSR projected a 1941 planned production of phenol formaldehyde plastic of 9,400 tons. 79/ This amount would be equivalent to about 4,700 tons of resin. Because the 1941 Plan has proved realistic for other chemicals, it has been assumed that 4,700 tons is roughly the 1940, or prewar, production level. It was planned that by 1950 production of these resins would increase by 225 percent over 1940 -- to a level of 15,300 tons. 80/ In 1953 the USSR announced that 1.5 times as much phenol formaldehyde molding powders were produced as in 1950. 81/ Thus production in 1953 may be estimated at about 23,000 tons. Assuming a similar rate of increase for 1954 as for the years 1950 to 1953, the estimated production would be 26,400 tons. This amount would require about 23,200 tons of phenol.

* P. 14, above.

6. Estimates of Inputs.

a. Inputs to Metallurgical Coke Operations.

A Soviet text has reported the average consumption norms of chemical raw materials used in Soviet coke chemical plants as of 1939. 82/ It is not believed that these norms would have changed substantially since then. The reported consumption is as follows:

Chemical	Consumption (Kilograms)	Use
Sulfuric acid (calculated as 100 percent)	750	Per ton of ammonium sulfate.
	55	For dehydration of 1 ton of phenol.
	50	Decomposition of phenolate residues, per ton of phenol present.
	80	Washing of 1 ton of crystalline naphthalene.
	70	Washing fractions from 1 ton of crude benzol.
Caustic soda* (93 percent)	450	Dephenolation of heavy oil fractions, per ton of phenol-cresol mixture.
	4	Washing and neutralization of benzol fractions, per ton of crude benzol.
	490	Dephenolation of light-middle fractions, per ton of phenol-cresol mixture.
Solar oil	150	Per ton of crude benzol.

On the basis of Soviet yield figures the production of crude benzol in 1954 is estimated at 560,000 tons. 83/ The use of caustic soda in the dephenolation operations has been calculated for both phenols and cresols, although cresols are not a subject of this report. Estimated production of cresols in 1954 was 18,000 tons, giving a total production of phenol-cresol of 31,000 tons.

* In calculating caustic soda inputs to high-temperature coke operations for production of benzol (Table 15, p. 24, above), consumption figures for dephenolation of heavy oil fractions and light-middle fractions per ton of phenol-cresol mixture were averaged.

b. Sulfuric Acid Input to Pyrolysis Operations.

On the basis of statements in a Soviet text, it is estimated that 6 percent of the total charge to the stills represents crude fractions of aromatic chemicals and must be purified by treatment with sulfuric acid. The Soviet text goes on to say that the expenditure of acid is about 10 to 15 percent of the fractions treated. The total charge in 1954 is estimated at 1.3 million tons, and acid input can be estimated at 10,000 tons. 84/

c. Inputs to Low-Temperature Carbonization Operations.

No figures are available giving the amount of caustic soda required to extract phenol from low-temperature tars. Stoichiometric calculations, however, show that 450 kilograms of caustic soda per ton of phenol extracted would be reasonable. Because it is assumed that carbon dioxide will be used to convert the sodium phenate to phenol, no sulfuric acid input has been shown. Estimated 1954 production of phenol from low-temperature operations is 12,100 tons -- requiring, therefore, 5,400 tons of caustic soda.

7. Estimate of 1944 Supply of TNT in the USSR.

Lend-Lease shipments of TNT to the USSR in 1944 amounted to 43,400 tons. In addition, 42,400 tons of toluol were supplied to extend the domestic production. 85/ Soviet production of toluol in 1944 is estimated at 45,000 tons -- 23,000 tons from pyrolysis and 22,000 tons from coke. Thus a total of 43,400 tons of TNT and 87,400 tons of toluol were available. Converting all the toluol to TNT gives a total of 225,000 tons of TNT.

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